

U. S. TREASURY DEPARTMENT
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U.S. PUBLIC HEALTH SERVICE
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REPORT OF THE JOINT COMMITTEE
ON BATHING PLACES

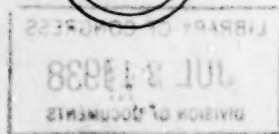
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DIVISION OF SANITARY REPORTS AND STATISTICS

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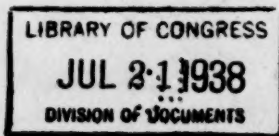
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It contains (1) current information regarding the prevalence and geographic distribution of communicable diseases in the United States, insofar as data are obtainable, and of cholera, plague, smallpox, typhus fever, yellow fever, and other important communicable diseases throughout the world; (2) articles relating to the cause, prevention, and control of disease; (3) other pertinent information regarding sanitation and the conservation of the public health.

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REPORT OF THE JOINT COMMITTEE ON
BATHING PLACES

FOREWORD

The Committee on Swimming Pools was appointed by the Sanitary Engineering Section of the American Public Health Association in December 1918. At the first meeting of the Conference of State Sanitary Engineers in May 1920, a similar committee was appointed, two of the three members being also members of the American Public Health Association committee. These committees have been continued from year to year; and since the personnel has always been practically identical, the two separate committees have worked together as one body. At the 1925 meeting of the Conference of State Sanitary Engineers and the Sanitary Engineering Section of the American Public Health Association each voted to merge the two separate committees into a Joint Committee on Bathing Places representing both organizations. Since 1925 the Joint Committee has presented six reports—in 1926, 1927, 1929, 1932, 1935, and 1937. The present report represents the culmination of these years of work and the group thinking of individuals most deeply concerned with and actively engaged in bathing place sanitation.

Publication of this report has been approved by the Conference of State Sanitary Engineers and by the Public Health Engineering Section, the Committee on Research and Standards, and the Governing Council of the American Public Health Association.

1938.

III

no. 139

REPORT OF THE JOINT COMMITTEE ON BATHING PLACES

Conference of State Sanitary Engineers and American Public
Health Association, 1937

Introduction

This committee has been asked to review the comprehensive reports of the former committee assigned to a study of this subject and present a report to both of our associations with a view to later acceptance by the Committee on Research and Standards of the American Public Health Association. The excellent pioneering reports prepared in 1925 and 1927 by the former committee headed by Stephen DeM. Gage have been used as a guide in swimming pool sanitation since they were published. In view of the completeness of these former reports, the present committee's report is to a considerable measure composed of the older reports. There are, however, some additions and modifications submitted, dealing largely with the following subjects: outdoor bathing places; cross-connections in swimming pools; streptococci tests; residual chlorine tests; foot infections; and bathing loads. Some of the discussion on these subjects is taken from the 1930 and 1932 reports of the Joint Committee. It should be understood that the bulk of this report as to swimming pools represents the work of Mr. Gage, *chairman*, and the other members of his former committees, to whom great credit should be given. No attempt has been made to revise the earlier reports except where changes were considered to be of importance.

Extent and prevalence of disease transmission by bathing waters.— This subject might be divided into two categories: those diseases which might be spread in relatively small swimming pools where the danger of transmission is from one bather to another, assuming a safe source of water supply, and those diseases which might be caused at outdoor bathing places where there are also the dangers from waters polluted by sewage from public sewage systems and other extraneous sources. Another distinction might be drawn as to the types of possible diseases: whether eye, ear, nose, and throat infections, skin infections, such as ringworm, eczema, scabies, etc., venereal infections, or gastrointestinal disorders.

In 1921 a committee of the American Public Health Association attempted to assemble data on the subject of spread of disease from

bathing waters by sending out 2,000 questionnaires to physicians and health officers of which 627 were answered. The replies indicated suspicions that most of the diseases to which man is susceptible may have been caused by contaminated bathing water or insanitary bathing place appurtenances. Despite these replies, it must be admitted that there is a great dearth of epidemiological information as to just what sickness is caused by bathing in polluted water.

Conditions pertaining to bathing waters are decidedly different from those surrounding public drinking water supplies. Many persons swallow little or no water during bathing—particularly is this true of salt water—and there is fairly rapid change of water at the majority of bathing places. These considerations tend to promote likelihood of occurrence of sporadic cases of such diseases as typhoid fever among bathers as against epidemics such as may occur with polluted drinking water supplies.

Considerable interest has been evidenced by many public health workers in the possibilities of spread of skin infections from bathing. Some cases of skin eruptions on the bodies of bathers have been reported. Some investigators have concluded that a skin infection designated as "Schistosome dermatitis" has affected bathers in the waters of lakes, rivers, ponds, or beach pools which support snails. The causative agent is said to be the *cercaria*, free swimming larval stage of certain parasitic worms of the family Schistosomatidae. Unfortunately it is a fact that little is known as to the exact manner of spread of many skin infections—whether the infection is spread by the use of bathing place appurtenances such as walkways, common towels, suits, or drinking cups, or by other contacts such as might occur on a public playground, or whether the water has acted simply as a vehicle of transmission of disease germs from one bather to another, or whether the infection has been from bodily excretions present in the water.

Eye, ear, nose, and throat infections are reported. Some of these might be due to lowering of resistance from chills; water may wash away protective mucous discharges containing antibodies, leaving the affected parts susceptible; harmful organisms already present in the body may be washed further into the ear and nasal passages during bathing; or excessive amounts of chemicals used for water purification may cause inflammation of mucous membrane and irritation of the skin. These are all possibilities aside from any harmful infections in the water.

The summary of the replies in the 1921 report, when considered in the light of known epidemiological evidence, leaves this committee unconvinced that bathing places are a *major* public health problem even though bathing place sanitation, because of the health consid-

erations involved, should be under careful surveillance of the public health authorities, and proper sanitary control of bathing places should be exercised. Indeed, this report is prepared for that particular purpose. It is realized that new epidemiological evidence may develop. It is agreed that common sense public health programs must recognize that bathing in polluted water is a potential danger, that insanitary conditions surrounding public bathing places are a hazard, and that common decency as well as health considerations dictate that reasonable steps should be taken to secure bathing in clean environments.

These conclusions are stated as an answer to a growing demand that this committee or some other group of public health workers propose a rigorous bacteriological or other standard, whereby bathing in certain outdoor bathing waters should be condemned from a public health standpoint. There is submitted in this report a proposed method of intelligent sanitary classification of outdoor bathing places with the inauguration of promotional educational programs to provide safe and more decent conditions as against extensive arbitrary programs of bathing place condemnation, and the recommendations of the 1927 committee toward provision of what are considered to be readily attainable and necessary sanitary precautions for swimming pools are also affirmed.

Drowning and other accidents at bathing places.—This report includes various recommendations of the former committee as to safeguards against drowning and other accidents at bathing places, particularly at swimming pools. These safeguards should receive consideration from health workers.

STANDARDS FOR DESIGN, EQUIPMENT, AND OPERATION

I. CLASSIFICATION OF BATHING PLACES

A. The term "bathing place" as used in this report includes all bodies of water sufficiently deep for complete immersion of the body and used collectively by numbers of persons for swimming or recreative bathing, together with the shores, buildings, equipment, and appurtenances pertaining to such bathing places. It does not include public or semi-public baths, where the main object is the cleansing of the body or the practice of the healing art, unless such baths contain pools or tanks used collectively by a number of individuals.

B. Bathing places may be divided into three classes:

1. Natural outdoor ponds, rivers, tidal waters, etc.
2. Outdoor pools which are partly artificial and partly natural in character.
3. Pools, outdoor or indoor, which are entirely of artificial construction.

Natural ponds and rivers are necessarily dependent upon natural flow or upon wind and wave action for circulation of the water. Artificial and partly artificial pools may be divided into four classes according to the method by which water cleanliness is obtained:

- a. Large semi-artificial pools in which the water cleanliness is maintained by natural flow or circulation.
- b. Fill and draw pools where cleanliness of water is maintained by complete removal and replacement of the water at periodic intervals.
- c. Flowing-through pools where cleanliness is maintained by circulation of water through the pool from some natural or artificial source, but where the outflowing water is wasted.
- d. Recirculation pools in which circulation of the water is maintained through the pool by pumps, the water drawn from the pool being clarified by filtration before being returned.

II. GENERAL PRINCIPLES OF BATHING PLACE SANITATION

A. In the control of swimming pool and bathing place sanitation certain broad principles apply to all classes of public bathing places.

B. The committee is of the opinion that all public bathing places, both natural and artificial, should be under the sanitary control of the public health authorities.

C. In the opinion of the committee the same standards of cleanliness and bacterial purity of the water and the same precautions

against the possible spread of disease should apply at both indoor and outdoor swimming pools.

D. The requirements should be the same for all artificial and semi-artificial pools whether located indoors or outdoors, so far as the features of design and equipment apply to maintenance of cleanliness of the pool and of the water with which it is filled.

E. At public bathing beaches on natural waters the same sanitary standards should apply to bathing houses, dressing rooms, toilet facilities, and to the handling and care of bathing suits, towels, and other articles of bathing apparel as would be required at artificial swimming pools.

F. Sanitary drinking fountains with a supply of pure water should be installed at all bathing places. The common use of towels, drinking cups, combs, hair brushes, or other toilet articles should be strictly prohibited.

III. BATHING BEACHES

This subject is discussed in Sections XXIX to XXXIV of this report at considerably greater length than in the 1927 report.

SWIMMING POOLS

IV. LOCATION AND LAYOUT OF POOLS

A. The location of an outdoor pool will be governed largely by local conditions; and arrangement of dressing rooms, etc., can be made to conform to the sanitary requirements. In locating an indoor pool careful study must be given to architectural and engineering features in order that the proper layout may be obtained.

B. The layout or arrangement of entrances and exits of the pool room in relation to dressing rooms, showers, and toilets must be such as to enforce proper routing of bathers. Coming from the dressing room a bather should be required to pass the toilets, and go through the shower room before arriving at the pool entrance. Bathers should leave the pool through a separate exit leading to toilets and dressing rooms.

C. At pools used simultaneously by both sexes separate entrances and exits should be provided for men and women. There should be no connection between men's and women's quarters.

D. Entrances and exits must be located at shallow water portion of the pool.

E. If the pool is to be of recirculation type, ample room must be provided for filters and other units. All recirculation piping, inlet and outlet valves, etc., must be located where they will be readily accessible.

F. At indoor pools where chlorine disinfection is to be used it is recommended that the chlorine apparatus be so located as to be readily observed.

V. DESIGN AND CONSTRUCTION FEATURES

A. *Material*.—Any material which will provide a tight tank with smooth and easily cleaned surfaces may be used for artificial swimming pools.

B. *Details of design*.—The details of design in so far as they relate to strength of material, water-proofing, etc., are essentially the same as in design of other tanks of similar size and shape and are, therefore, omitted from this report.

In the design of a new pool provision should always be made for complete circulation of water through all parts of the pool during the bathing period. Without proper circulation it is difficult or impossible to maintain good sanitary conditions at all times, even though the pool be completely emptied, cleaned, and refilled each day. The installation of new fill and draw pools cannot be recommended.

C. *Shape*.—Indoor pools should be of rectangular shape with deep water at or near one end and shallow water at the other. Small outdoor pools should be of the same general design as indoor pools. The best shape for large outdoor pools depends largely on the size and on local conditions. It is considered better practice to build large pools with the deep water area in the center.

D. *Dimensions*.—For swimming records a straightaway course of at least 60 feet with 5-foot lanes is required. Length of pool should be not less than 60 feet and width should be some multiple of 5 feet. The area to be provided for the expected bathing load is discussed in a subsequent chapter.

E. *Depth of water*.—The minimum depth of water in the deep portion of any public pool should be not less than 6 feet.

F. *Proportion deep and shallow*.—Some authorities recommend that the area of shallow water, 5 feet or less in depth, should be 80 per cent or more of the total area of large outdoor pools. Such proportioning must be considered in relation to the pool volume, the bathing load, the recirculation or flowing-through purification system, etc. The committee has insufficient information on this point to warrant any recommendation at the present time.

G. *Slope of bottom*.—The slope of the bottom of any part of a pool where the water is less than 6 feet deep must not be more than 1 foot in each 15 feet. There should be no sudden changes of slope within the area where water depth is less than 6 feet.

H. *Side walls*.—The side and end walls of all artificial and semi-artificial pools should be vertical. Sloping side walls are dangerous and cannot easily be kept clean.

I. Pool lining.—Including bottom and sides up to runways lining must be of white or light colored material and present a smooth finished surface without cracks or joints. All corners must be rounded. Tile or glazed brick lining is recommended for all indoor pools and for small outdoor pools. White cement smoothly finished is satisfactory for large outdoor pools. Dirt does not show on asphalt or other similar dark material and such materials are not suitable for pool lining. Sand or earth bottoms cannot be kept clean and are not recommended for pools.

J. Markings.—It is recommended that swimming lanes be marked on the bottom with dark colored material of the same kind as pool lining. The outlet of the pool should also be plainly marked by a black or dark colored circle, unless outlet grating is of conspicuous coloring. The depth of water at the deepest point and at the 5-foot point should be conspicuously marked on both sides of a pool with deep water at one end. Markings showing depths in 1-foot increments are desirable. In large pools with deep water only in the middle the 3- and 5-foot depth line should be conspicuously marked on the bottom and also designated by surface floats.

VI. PROPORTIONING POOL AREA TO EXPECTED LOAD

A. In the design of an artificial pool due allowance must be made for the number of bathers who may be expected at the time of maximum use. In computing the area which must be provided it is recommended that the pool be divided into three zones, and the area of each computed separately.

B. From the data collected by the committee for its fifth report it was the consensus of opinion that an area extending 10 feet from the extremity of a diving board or tower should be considered as reserved for divers, and that not more than two or three persons should be permitted in the water in this area at one time while diving is in progress. About three times that number will be on the shore or diving platform awaiting their turn to dive. Twelve persons is therefore the maximum number which may be permitted for the area within a 10-foot radius of each diving board or platform.

C. It was the consensus of opinion of swimming pool operators that the space required by a swimmer might fairly be expressed as five-fourths the square of his height and that on an average two-thirds of the swimmers present would be in the pool at the same time. On this basis the average space requirement for an adult swimmer is 40 square feet and allowing for one-third of swimmers on the shore, an average of 27 square feet should be provided for each swimmer who may be expected to be present at time of maximum load.

D. In computing the area to be provided for persons who do not swim we must take into consideration the character of the pool. At indoor pools and small outdoor pools this area should probably be included with the swimming area and the crowding limit computed as such. At large outdoor pools where a considerable proportion of the water is shallow water, we may assume that 50 per cent of the non-swimmers would be on shore. The average space allowance for each non-swimmer in the water is approximately one-half that of the swimmer in deep water. Combining these factors an allowance of 10 square feet per bather should be allowed for this portion of the pool.

VII. INLETS AND OUTLETS

A. All pools should be provided with an outlet at the deepest point of sufficient size to permit the pool to be completely drained in four hours or less. Outlet opening in the floor of the pool should be at least four times the area of the discharge pipe to reduce suction currents. This opening must be covered with a proper grating.

B. In rectangular pools with deep water at or near one end, multiple outlets should be provided where the width of the pool is more than 20 feet. In such cases outlets should be spaced not more than 20 feet apart, nor more than 10 feet from sidewalls.

C. Proper pipe connections must be provided in recirculation pools to permit water being drained to the sewer as well as to recirculation pumps. No direct connections to sewers should be permitted and all pool drains to sewers should be broken at a point where any sewage which may back up from the sewer will overflow to waste instead of being permitted to reach the pool. Pumping of pool drainage to an elevation above any possible sewer backing may in some cases be needed.

D. Inlets for fresh or repurified water should be located to produce so far as possible uniform circulation of water and the maintenance of a uniform chlorine residual throughout the entire pool. In semi-artificial pools of irregular shape a careful study should be made of probable circulation currents, and inlets should be located and spaced to provide as complete circulation as possible. Inlets from the circulation system should be submerged to reduce escape of chlorine odors. Where water from the public water system is added to the pool, cross-connections between the public water system and the swimming pool water should be eliminated by pumping make-up water from a pump suction well or admitting water to the pool above the overflow elevation of the pool. It is recognized that the avoidance of cross-connections in this manner may require the installation of a separate heater on the line supplying make-up water—particularly where large amounts of make-up water are added.

E. Where the distance across the shallow portion of the pool is more than 20 feet, multiple inlets must be provided, so spaced that each inlet will serve a linear distance of not more than 20 feet. At spoon-shaped rectangular pools where the outlets are located more than 5 feet from the end wall, inlets should be placed at both ends of the pool. At large pools with outlets near the center, inlets should be placed at the specified intervals entirely around the perimeter of the pool.

F. Each inlet should be designed as an orifice and proportioned to supply the volume of water required at that particular point to obtain the best circulation. Inlet piping should be designed to provide at least twice the area of the inlet orifice. In large pools the inlet pipe system should be designed in sections with gates to permit regulation of the flow to different inlet orifices.

G. In a few cases pools have been designed for fresh water or re-purified water to enter at the deep point and overflow through outlets or scum gutters in the shallow portion. It is believed there may be some advantage in having flow through the pool in this direction, thus permitting floating matters and dirtier water from the more crowded shallow area to be carried off more rapidly. The committee suggests that in designing piping systems for recirculation or flowing-through pools, connections be provided so that flow through the pool may be in the direction which experiments may prove most desirable. It is also suggested that the question of having scum gutters serve as overflows and outlets in recirculation or flowing through systems be studied more carefully, as it appears that such design may have certain material advantages.

VIII. SCUM GUTTERS

A. Scum gutters should extend completely around the pool. The design of scum gutters should be such that matters entering them will not be washed out by a sudden surge of entering water, and that danger of bathers catching arms or feet in them be reduced to a minimum. The edge of a scum gutter should be designed to serve as a hand hold for bathers. Gutters should, therefore, be sufficiently deep that bathers' fingers will not reach to the bottom. Sufficient opening must be provided to permit mechanical cleaning of the gutters.

B. Drainage outlets should be provided at least every 10 feet and the gutter bottom should pitch slightly to these outlets. Outlets and outlet pipes should be of generous size to permit rapid carrying away of water during surface flushing or reversed flow. Drainage from scum gutters may be conducted directly to sewers or to suction of recirculating pumps. Both such connections are advised.

C. All scum gutters should be recessed into the pool wall. There is no legitimate objection to having scum gutters project slightly into the pool to permit drainage from runways to flow directly over the edge of the pool into them. Such projection should not, however, be more than 2 inches.

IX. STEPS, LADDERS, AND STEP HOLES

A. Steps or stairways for entering and leaving the pool should be of such construction as to minimize danger of accidents. Ladders or stairways should be located at one or both sides of the deep end of the pool. If the distance from the bottom of the pool to runway is more than 2 feet, a ladder or steps should also be placed at the shallow end of the pool. Treads of ladders or steps should be of non-slip material.

B. In some pools ladders have been replaced by step holes inserted in the pool wall. If step holes are provided, they should be of such design that they may be readily cleaned and be provided with drains into the pool to prevent accumulation of dirt.

C. Stairs, ladders, or step holes should have a hand rail on either side at the top leading out over the runway. Stairs should not project into the pool. If stairs are desired, the stairway should be recessed into the wall and the runway of the pool.

X. RUNWAYS OR SIDEWALKS

A. Runways not less than 4 feet wide should extend entirely around the pool. Runway floors should have a slope of about $\frac{1}{4}$ inch to the foot, should be smooth and easily cleaned, but should be as far as possible of non-slip construction. The edge of the pool runway must be of non-slip construction for a width of at least 1 foot. The edge of the pool at its junction with the runways should be rounded. At indoor pools, unless runways are very wide, handrails on the outside wall are desirable.

B. The older practice was to require runways of all pools to slope away from the pool with drainage vents at intervals connecting with the sewer. Such a requirement seems unnecessary for indoor pools. The water carried out on runway is of the same character as that in the pool. Modern trend of opinion is toward having runways of indoor pools slope toward the pool with drainage into scum gutter or scum gutter drainage system. At outdoor pools so located that much dirt is blown in from outside it is desirable to have the runways slope away from pool to permit flushing such dirt directly to the sewers.

C. Some sanitary authorities also require a raised edge 2 inches or more in height between the pool and runways. Such a raised edge may lead to accidents by bathers tripping thereon and cannot be recommended for indoor pools. At outdoor pools a raised edge forms a barrier between pool and runway and permits the use of greater hose pressure for flushing. If installed for this purpose, such an edge should be not less than 1 foot wide and at least 6 inches high in order that danger of accidental tripping may be reduced as much as possible.

D. High, tight walls should encircle the pool outside the runways. Some outdoor pools have been constructed with areas of sand or grass and shrubbery just outside the runways. This practice is objectionable as it leads to tracking of much dirt into the pool. Trees and shrubbery overhanging or adjacent to the pool or runways are also objectionable and may cause unnecessary dirt in the pool.

XI. VISITORS' GALLERIES

There must be an absolute separation of the space used by spectators and that used by bathers. There should be no means by which bathers can enter space reserved for spectators or *vice versa*. Visitors' quarters must have a separate entrance. Galleries for spectators should not overhang any portion of the pool surface. Floor and foot rail of the gallery should be of tight construction to prevent dirt tracked in from getting into the pool. Gallery floor should slope to a drain and should be flushed down with hose regularly. Seats in galleries should be of non-absorbent construction to permit washing.

XII. DRESSING ROOMS

A. Bath houses to be used simultaneously by both men and women should have two parts, one for each sex, entirely separated by tight partitions.

B. Floors of all dressing rooms and locker rooms should be of smooth finished material, impervious to moisture, with no open cracks or joints. All floors should have a pitch of about $\frac{1}{4}$ inch to the foot and should slope to a proper drain to permit washing down with a hose. All junctions of the floors with sidewalls and partitions should be finished with rounded joints.

C. Walls and partitions of all dressing rooms and locker rooms should be of smooth, impervious material, without open cracks or joints. If walls of wood or similar material are used, all cracks and joints should be filled and the surface kept finished with paint or other sanitary waterproof coating. Partitions between dressing com-

partments should terminate not less than 4 inches above the floor to permit flushing of the entire floor area.

D. All furniture used in dressing rooms should be of simple character and of easily washable material. Lockers where provided should be of vermin proof construction with tight joints. All lockers should be properly ventilated.

E. All dressing rooms and appurtenances must be kept clean at all times. The use of an insecticide spray for lockers and of a disinfectant on floors, walls, and seats at frequent intervals is recommended. A 0.3 to 0.6 per cent solution of available chlorine is suggested as a disinfectant, to prevent the spread of foot infections. Foot tubs without proper disinfectant solution should be prohibited.

XIII. SHOWERS, TOILETS, LAVATORIES

A. Adequate shower bath facilities with hot and cold water should be provided at all artificial pools. The minimum number of showers provided should be in the proportion of one for each 40 bathers expected at time of maximum load, in the case of continuous bathing. For bathing by classes, as at schools, the number of showers may be taken as one-third the number of pupils in the maximum class.

B. Shower baths should be of such design that a proper mixture of hot and cold water may be obtained without danger of scalding the bather. A Bidet or upward flow spray beneath each shower to permit washing between the legs is desirable.

C. A foot trough with running water is desirable at entrance to outdoor pools and to beach bath houses. At certain pools operated in conjunction with surf bathing, it has been found advisable to make a wading pool of the entrance passage with automatic or continuous flow showers overhead, through which all bathers must pass on return to the pool.

D. At public bathing beaches a sufficient number of showers should be provided to permit all bathers to rinse off sand and dirt before entering the dressing rooms.

E. Adequate and proper toilet facilities for each sex must be provided at all pools and beach bath houses. The minimum number should be one toilet for each 40 women and one toilet and one urinal for each 60 men. Urinals should be of a type that will not cause splashing of urine upon legs and feet of bathers. Urinals and toilets should be so located that bathers will use them before entering the showers on their way to the swimming pool.

F. Water flush toilets should be provided wherever possible. All toilets must be properly maintained.

G. Lavatories located adjacent to toilets should be provided at all swimming pools in the proportion of one bowl to each 60 persons using the pool at time of maximum load.

H. The use of solutions containing 0.3 to 0.6 percent of available chlorine has been found of value as a foot wash for the prevention of so-called "athlete's foot." At many swimming pools, bathers are required to rinse their feet in such a solution before entering the pools. Many authorities consider it preferable to place the foot bath at the exit from the showers to the dressing rooms so as to spread the chlorine over the dressing room floor and increase the time of contact. In some cases, 15 percent sodium thiosulfate solutions have been used with success as a preventive foot wash but in one large city poor results with this chemical have been reported. One reason attributed to lack of success with sodium thiosulfate is failure to employ freshly made up solutions using a good grade of chemical. Sodium thiosulfate is a reducing agent and will reduce the available chlorine in the pool if bathers use it in a foot bath before entering the pool so that its use should be limited to bathers leaving the pool.

Another interesting recent development is a report from Detroit, Michigan, that Doctor Loren Schaffer has conducted successful experiments with a 10 percent by weight of salt (NaCl) solution for control of "athlete's foot." More data on this treatment will be awaited.

XIV. LIGHTING, VENTILATION, HEATING

A. A complete system of artificial lighting must be provided for all pools, bathing beaches, bath houses, and dressing rooms which are to be used at night.

B. Lighting fixtures must be of such number and designs as to light all parts of the swimming pool and the water therein.

C. Arrangement and design of lights must be such that life guards may see clearly every part of the bathing waters at a beach or pool, and all spring boards, towers, floats, and other appurtenances, without being blinded by the light.

D. Indoor pools should be so located that they may be lighted during the day by windows on at least one side or by skylight. The window or skylight area should not be less than one-half the area of the pool including the runways.

E. All indoor pools and all bath houses, dressing rooms, shower rooms, and toilets at both indoor and outdoor pools and beaches, must be properly ventilated. Ventilation of indoor pool rooms must be so designed that direct draft will not blow on bathers.

F. All heating units shall be isolated or protected from contact with bathers to prevent injury. The heating units in dressing rooms, shower rooms, and toilets shall be capable of maintaining a temperature of between 70° F. and 75° F. The pool room heating units shall be capable of maintaining a temperature between 75° F. and 82° F. Thermostatic control of the temperature is desirable.

G. The acoustical property of pool rooms has not received the attention it deserves. Designs and materials of construction which will prevent reverberations of sound that result in confused noises should be used. It is very important that an instructor's voice or a call for help may be clearly distinguished.

XV. RECIRCULATION SYSTEM

A. *The system.*—The recirculation system consists of the pumps, hair catcher, and filters together with all necessary pipe connections to the inlets and outlets of the pool. The water heater, the chlorinator and the suction cleaner are also usually installed on or connected with the recirculation system and may be considered as integral parts thereof. This entire system and all its component parts should be designed to provide the required volume of recirculation water as specified in section XVI B with a minimum of frictional resistance. Filtration and disinfection are discussed separately in subsequent chapters. The requirements for other parts of this system are as follows:

B. *Pumps.*—Centrifugal pumps are preferable for swimming pool circulation, although plunger pumps are sometimes used. Electric drive is also preferable. When pipe lines from suction cleaner lead to pump suction, a pump which will develop good vacuum must be used. When pressure filters are used pumps must be designed to pass the required volume under the maximum head which may develop in the filters. When designed to operate with multiple unit filters it is advisable to have pumps in duplicate with proper cross-connections to permit one filter to be washed with the effluent from another. If filters are located at an elevation higher than the water line of the pool a check valve must be placed on the pump suction.

C. *Hair catcher.*—The recirculation system should include a strainer to prevent hair, lint, etc., from reaching the filters. The best type of hair catcher consists of a metal chamber containing a removable cylindrical strainer, so arranged that the water passes through the strainer from the outside. The strainer should be of non-corrosive material with openings not more than $\frac{1}{32}$ inch across. A slotted strainer is more easily cleaned than one which is perforated. The area of strainer openings should be at least ten times the area

of the water inlets. Hair traps should be so constructed that they can be quickly taken down for cleaning by loosening two or three wing-nuts. Proper valves should be provided to prevent flow of water through the strainer while cleaning.

D. *Water heater*.—In northern climates some method of heating the water is essential for indoor pools. Blowing steam directly into the pool, as is practiced in some instances, or heating coils placed directly in the pool are not recommended. A heater designed to heat all or a part of the circulation water is preferable. In designing a heater, ample surface for heat interchange must be provided. Such a heater may be designed for use with steam or hot water. Automatic thermal control is desirable. Provision should be made for easy removal of the heater parts for cleaning.

E. *Suction cleaner*.—In the opinion of the committee the only satisfactory method of removing the dirt, hair, etc., settling on the bottom of a pool is by means of a suction cleaner. As such cleaners are commonly operated by the circulation pumps, they may be classed as an adjunct to the recirculation system. When a suction cleaner is to be operated by the recirculation pump, a gate with graduated stem or other registering device should be provided for throttling the flow from the pool outlet to permit the pump to operate at maximum efficiency when the suction cleaner is in use. Fixed pipe connections below the water surface for attachment of suction cleaner to pump suction should be of ample size to reduce friction to a minimum and the cleaner and all removable connections should be designed to provide a maximum velocity at the suction nozzle.

F. *Piping system*.—The piping system should be properly designed to reduce friction losses to a minimum. Pipe capacities should generally be at least double the theoretical value. Flange joints or unions should be inserted at intervals to permit any part of the system to be quickly taken down for cleaning or repairs. A sump and blow-off should be provided at the lowest part of the system to permit removal of any accumulating iron rust. Openings should be provided for insertion of gauges to permit vacuum or pump suction and pressure at discharge to be determined, should a study of the recirculation system be desirable. It is advisable also to make provision for insertion of Pitot tubes or meters for checking the actual volume of water passing through the system under working conditions. Outlets should be provided for obtaining samples of the water as it leaves the pool and after filtration for purposes of laboratory tests. Other requirements for piping are discussed under the heading "Inlets and Outlets."

It is recommended that piping used for different purposes be painted distinguishing colors.

G. *Testing the system.*—After the recirculation system has been installed and the various units tuned up, a test of the hydraulic properties of the entire system and of each integral unit should be made. In such a test the velocity in the piping system at various points, the discharge capacity of each filter and each pump, the velocity and volume of wash water in each filter, and the rate of discharge at each pool inlet should be determined under actual working conditions with the pool at normal working level. The full data of this test should be a matter of permanent record for future comparison. A similar test repeated at least once a year is desirable.

H. *Thermometers.*—At indoor pools a fixed thermometer shall be placed on the recirculation line beyond the heater and another near the outlet of the pool. At outdoor pools one thermometer is usually sufficient. Thermometers shall be accessible and have a type of scale that is easily interpreted.

I. *Cross-connections.*—The avoidance of cross-connections on the pool piping system whereby pool water may under some conditions enter a potable water supply system which is connected either for admission of new water to the pool or for washing of filters is discussed in sections VII D and XVII E. The possibility of polluting pool water from sewer connections is discussed in section VII C. The dangers of cross-connections are also stressed under this heading.

XVI. PROPORTIONING THE WATER INTERCHANGE FOR RECIRCULATION AND FLOWING-THROUGH POOLS

A. In a recirculation or flowing-through pool in which the dirty or used water is continually being withdrawn and replaced by fresh or filtered water, purification of the pool water proceeds by consecutive dilution. The first portion withdrawn from the pool will all be dirty water but, owing to the constant admixture of entering clean water with the dirty water remaining in the pool, each succeeding portion of water withdrawn will consist of a decreasing proportion of dirty water mixed with an increasing proportion of clean water. In proportioning the rate at which fresh water should be added to a flowing-through pool, or the capacity of pumps, filters, etc., for a recirculation pool, this law must be taken into consideration.

B. Gage and Bidwell have worked out the law of purification by consecutive dilution as applied to recirculation and flowing-through pools and this is described by them as follows:

It is proposed that the rate of water interchange in a recirculation or flowing-through pool be expressed as the ratio of the volume of clean water entering the pool in 24 hours to the total pool volume. For convenience this ratio may be called the "Turnover" rate or "*T*"

of the pool purification system. For example, $T=1$ when the volume of water recirculated in 24 hours is the same as the pool volume, $T=2$ when the water circulated in 24 hours is twice the pool volume, etc.

It can readily be demonstrated by computation and by experiment that 7 turnovers are required to effect a removal of 99.9 percent of the dirt present in the water of the pool when recirculation was started. At the end of the first turnover the purification will be about 63 percent, after two turnovers about 86 percent, at the end of three turnovers about 95 percent, after four turnovers about 98 percent, after five turnovers 99.3 percent, and after six turnovers 99.7 percent. To accomplish a purification of 99.99 percent 10 turnovers will be required.

If the pool is used regularly by bathers further increments of dirt will be introduced into the water daily, and the removal of each successive daily increment will proceed according to the law. The result of the addition of such daily increments will be an increasing accumulation of dirt in the water up to a certain point, after which the dirt content of the pool water will remain practically constant, subject only to the fluctuations caused by the variations in the daily bathing load. The amount of this accumulation and the time required for the pool water to reach a condition of equilibrium depend upon the rate of turnover of the pool by the flowing-through or by the recirculation system, and in the latter system is also dependent upon the efficiency of the filters.

Assuming a daily increment of dirt equal to that in the pool at the start and a filter efficiency of 100 percent, with a daily turnover ($T=1$) equilibrium will be reached at the end of the ninth day when the accumulated dirt in the pool will be equivalent to about 58 percent of the amount present when recirculation and daily bathing was started. With two turnovers per day ($T=2$) equilibrium will be obtained in four days with a dirt load of about 16 percent, with $T=3$ a balanced load of about 5 percent will be obtained on the third day and with $T=4$ a balanced load of about 2 percent will be obtained at the end of the second day. On the other hand, if the recirculation system is so small that it requires two days for each turnover, accumulation of dirt in the pool will continue for about nineteen days and the dirt load carried in the pool thereafter will be about 155 percent of the amount present at the start.

It is evident, therefore, that if clean water is to be maintained, the recirculation or flowing-through system must be designed to provide a turnover ratio of at least two and that where heavy bathing loads are anticipated, the turnover ratio should be three or more. It is also evident that the recirculation or flowing-through system should be kept in operation continuously and that the filters should be operated in the most efficient manner. If the filters have an

efficiency of only 50 percent, or the recirculation system is operated only half the time, the effect will be the same as though the recirculation system were only half the size.

XVII. FILTRATION

A. Slow sand filters, rapid gravity filters and pressure filters have all been used in swimming pool repurification systems. More than 80 percent of the recirculation pools in this country are equipped with pressure filters and for indoor pools and small pools where space is limited, this type of filter is to be preferred unless the water is very hard. For large outdoor pools the gravity type rapid filter is suitable and is preferred by some sanitary authorities. Where the water is very hard and cementation of the filter medium is likely to occur the open type of filter is to be preferred. Because of the large amount of space required, and the increased amount of hand labor required in cleaning, slow sand filters are seldom used for swimming pools.

B. Batteries of three or more filters arranged in parallel are preferable to a single unit, in order to permit continuation of filtration and recirculation while one unit is out of operation for cleaning or repairs.

C. Filtering material should consist of at least 36 inches in depth of suitable grades of screened sharp filter sand or crushed quartz and filter gravel. Experience has shown that satisfactory results are secured when the effective size of the sand is about 0.4 to 0.5 mm with a uniformity coefficient not exceeding 1.75. Sand should be washed free from clay, organic matter, and soluble material. There should be at least 18 inches of freeboard above the surface of the filter material to the overflow troughs or pipes of rapid filters to permit proper washing without loss of filter sand. In some cases filters of bone charcoal, wood charcoal, or similar material have been installed on swimming pool recirculation systems. When new these materials may have considerable absorptive effect, but after a few weeks' use this power is lost and the filter becomes practically worthless until the filter medium is renewed.

D. In designing a filter system for a swimming pool the rate of slow sand filters should not exceed three million gallons per acre per day, and the rate of rapid filters should not exceed three gallons per minute per square foot of surface area. Automatic rate controllers are essential on slow sand filters. Rate controllers are not usually installed on the rapid filters used for small swimming pools because of the considerable increase in cost. Filters for large pools (100,000 gallons or more) should be equipped with rate controllers and such control is desirable on smaller installations.

E. Rapid filters of open gravity type must be equipped with loss of head gauges. Pressure filters must be equipped with pressure gauges on both the inlet pipe and the outlet pipe for determination of loss of head or back pressure in the filter medium. Pressure filters should have a proper sight glass installed on the waste discharge pipe by which the operator may watch the progress of filter washing. Such glass should be readily removable for cleaning, and should be kept clean. When pressure filters are located at an elevation above the water line of the pool, each filter must be equipped with an automatic air relief valve. The arrangement and number of valves and interconnecting piping, or "valve nest," for necessary and convenient operation of rapid filters is fairly well standardized, and a discussion thereof may be omitted. It is usually desirable to have 3 or preferably 4 pressure filter units so that 1 unit can be cut out of use and washed with the filtered pool water. With 4 filter units in ordinary use, 1 filter can be washed with the use of the recirculation pump at 4 times the ordinary filtering rate. If washing with the recirculation pump is not feasible, a wash water pump of higher capacity may be installed and a suction well or small elevated feed tank, supplied from above with water from the public water system, can be used to supply water to the pump. Valved cross-connections whereby water from a potable water supply may be admitted directly to the recirculation system for the purpose of filter washing may permit pool water to gain access to the potable water supply because of leaking valves or suddenly lowered pressures. They shall not be permitted in the case of new swimming pools. In some instances, the elimination of existing cross-connections between potable water supply systems and swimming pools is difficult. Each case should be considered in the light of existing conditions, and remedies should be sought as dictated by the relative danger and the practicality of carrying out improvements. Where such cross-connections are permitted to remain in existing swimming pools, extraordinary precautions should be required to safeguard the potable water supply.

F. Readily removable heads or a large manhole should be provided on pressure filters to facilitate inspection and repairs. Sufficient head room and working space must be allowed about filter units of all types to permit sand replacement and other repairs when necessary.

G. If the water supply contains iron, manganese, turbidity, or any appreciable amount of color, treatment with alum or other coagulant will be necessary with slow sand filters as well as with filters of the rapid flow type. On filters for pools of more than 50,000 gallons capacity, solution tanks and orifice boxes are to be preferred to the "Alum Pot," so-called, which is usually installed for use with small filters.

H. When the water supply for a pool contains large quantities of calcium bicarbonates, and especially when such water must be heated for use, difficulty is often experienced in maintaining clear water in the pool by the usual methods of coagulation and filtration. To a certain extent this difficulty may be overcome by passing the alum-treated water through a properly designed coagulation and sedimentation basin before filtration. Where the installation of a proper coagulation basin is impracticable it is suggested that water softening apparatus of the zeolite or base exchange type be installed as an adjunct to the recirculation system to permit the calcium content of the pool water to be reduced to a reasonable amount.

XVIII. DISINFECTION

A. From all available information, the addition of chlorine either as a gas or in a water solution by use of proper apparatus is today the most satisfactory method of pool disinfection. It is possible not only to disinfect the entire body of water in the pool completely with chlorine, but also maintain in the pool water at all times a residual amount of disinfectant to counteract at once any dangerous pollution disseminated by bathers. With the proper chlorine apparatus it is also possible to increase or diminish the dosage as required to compensate for variations in the bathing load. The committee recommends the use of chlorine either as a gas or in a water solution for disinfection of all pools where there is any appreciable bathing load, or where bathing suits are worn. Recent developments indicate that the use of ammonia and chlorine for swimming pool disinfection has become increasingly popular because of the more lasting qualities of the chloramines thus formed and the possibility of carrying higher disinfecting dosages without production of irritating effects from the use of large amounts of chlorine. Reports have reached the committee that much more satisfactory results from the standpoint of avoidance of loss of chlorine from disinfected swimming pool water and of less trouble with chlorine odors have been obtained by carrying high alkalinities in the water. Experiments indicate a delayed germicidal action of chlorine with high accompanying pH content of the swimming pool water, decidedly so at a pH of 7.7, which is a factor to be considered. The fact that chloramines are decidedly slower acting disinfectants than chlorine alone makes it appear to the committee that chlorine is a safer disinfectant than chlorine and ammonia, although under some conditions, such as in very large or outdoor pools, chloramine disinfection may produce better over-all results.

Attention is called to experience in some pools where chlorine and ammonia have been used and where there has been developed the presence of excessive amounts of nitrites. These have caused false readings with the orthotolidin test for residual chlorine. The committee recommends that where chlorine and ammonia are used, frequent nitrite determinations be made on the swimming pool water in addition to the check routine bacteriological examinations. Even in pools where chloramine disinfection is not employed, it may prove advisable to make some tests for nitrites. They have been found to a noticeable extent occasionally in such pools.

B. The hazard of accidental escape of chlorine gas into public buildings is such as to warrant special precautions. It is suggested that:

1. The chlorine and chlorine equipment should be placed in a separate room which is reasonably gas tight and equipped with air education ducts beginning near the floor level and terminating out of doors. It is preferable to equip such rooms with forced mechanical ventilation capable of changing the air therein at least twice each minute. If the location is below ground level, such mechanical ventilation should be considered a minimum requirement, since chlorine gas is heavier than air and will not rise from sub-ground levels.

2. The chlorine equipment placed therein should be of rugged design capable of withstanding reasonable wear and tear without developing leaks.

3. Some form of protection should be provided for emergencies. Several types of gas masks approved by the U. S. Bureau of Mines and suitable for high concentrations of chlorine are available. For this purpose, a sufficient number of suitable gas masks should be at hand and located at a readily accessible point outside of the area likely to be affected in case of accident. The instructions accompanying a mask concerning its care and use should be obeyed implicitly. Everyone who is in danger of being accidentally exposed to high concentrations of chlorine should be provided with a gas mask. Periodic strict inspection and maintenance of approved gas masks are essential.

C. There are now on the market machines which feed hypochlorite solutions for disinfection. Chlorine compounds may be used to make up fairly stable disinfecting solutions and so long as their strength is checked by means of residual chlorine tests on the pool water, they may be very satisfactory. There are also chlorinators in use which produce chlorine by electrolytic action on sodium chloride solutions.

D. Intermittent disinfection with hypochlorites as practiced at many pools must be considered a makeshift. It is possible to obtain satisfactory disinfection by intermittent application of these chemicals and to maintain a satisfactory residual chloride content in the water when the bathing load is constant and not too high. When the bathing load fluctuates widely the residual chlorine content cannot be adjusted to compensate for these variations and under excess loads immediate disinfection of infectious matters from bathers may not be accomplished.

E. Disinfection of clear water may be obtained by exposure in thin films to ultra-violet rays. It is claimed by the proponents of this method of swimming pool disinfection that the water after treatment contains a residual disinfecting agent whose action is similar in effect to that which is obtained by the use of a slight excess of chlorine either as gas or in solution. So far as the committee have been able to determine no conclusive evidence has been produced to establish the claim. Until such evidence is produced it must be assumed that disinfection by this process proceeds according to the law of purification by consecutive dilution and is subject to the limitations imposed by that law. On this assumption there is never any definite and determinable amount of disinfectant in the pool water to act on infectious material which may be discharged by bathers during the bathing period at the time when such material is most dangerous. In a few cases satisfactory control of the bacterial content of pool water has been reported by the use of ultra-violet disinfection alone. In a considerable number of instances, however, it has been found advisable to reinforce or supplement the ultra-violet treatment by treatment of the pool with chlorine or hypochlorites. Until reliable evidence is produced that ultra-violet treatment will cause the pool water to contain a sufficient residual disinfectant to take care of casual contamination and until methods have been devised by which any such residual disinfecting action can be readily determined and controlled, the committee cannot recommend the use of violet-ray apparatus alone for disinfection of any pool where the bathing load is high or where large temporary loads are likely to occur.

F. Judging from a few reports, a reasonably satisfactory disinfection of water may be accomplished by ozone when the necessary apparatus is properly installed and operated. The data on the use of ozone for swimming pool disinfection are very few and inconclusive. There is no evidence that ozone has any residual sterilizing effect after the water has been treated, and disinfection must, therefore, proceed according to the law of consecutive dilution and be subject to all limitations imposed by that law. On the basis of any available evidence,

the committee cannot recommend this method for swimming pool disinfection.

G. The committee recommends the use of copper sulfate in combination with either of the approved methods of disinfection at such times and in such amounts as may be necessary to control growths of algae in swimming pools and other bathing waters. The use of copper salts alone as a disinfectant will not produce satisfactory bacterial control and cannot be recommended.

H. The use of ionized silver for swimming pool disinfection has been developed abroad and to a very limited extent in this country. While satisfactory bacteriological conditions have been reported in pools using such treatment, there is a question as to how rapidly this disinfectant acts on infectious material which may be discharged into the pool water by bathers. Hale and Shapiro report poor disinfection with ionized silver treatment in New York City in experimental tests and during five months' practical tests in a swimming pool and call attention to the relatively high cost of such treatment and to interfering substances such as ammonium salts. Mallmann also reports on operating results in a pool where ionized silver treatment was tried. He concludes that silver appears to be slower in its germicidal action than chlorine when applied in a disinfectant for swimming pools and bathing loads must be lower for silver treated swimming pools than when chlorine is used. He found three non-pathogenic bacteria that grew abundantly in swimming pool water containing silver. In the light of available information the committee cannot recommend the use of ionized silver for swimming pool disinfection.

XIX. DIVING TOWERS, SPRING BOARDS, AND FLOATS

A. Diving towers, when provided, shall be rigidly constructed and properly anchored to the bottom with sufficient bracing to insure stability under the heaviest possible load.

B. Fixed platforms and floats in the water shall be constructed with an air space of at least 1 foot beneath. There must be as little under water construction in such platforms as is consistent with strength, and all braces, struts, etc., shall be designed to prevent entanglement or trapping of bathers beneath the platform.

C. At least 12 feet free and unobstructed head room must be provided above diving boards and towers.

D. No diving board or platform more than 10 feet above water level should be permitted at any public place. The elevation of diving boards or towers should not exceed the safe limit for the average swimmer. The consensus of opinion of swimming instruc-

tors, etc., as summarized in the fifth report of this committee apparently establishes the following as the minimum safe depth of water for diving from various elevations:

Elevation of diving platform:	<i>Minimum safe depth of water</i>
1 foot-----	5 feet
3 feet-----	6 feet
5 feet-----	7 feet
7 feet-----	8 feet
10 feet-----	9 feet

XX. EMERGENCY EQUIPMENT

A. Pole hooks, ropes, buoys, and other necessary life saving equipment must be provided and be readily accessible at all pools and bathing beaches.

B. A first-aid kit containing aromatic ammonia, tincture of iodine, sterile gauze, absorbent cotton, surgeons' plaster, and bandages of various widths should be provided for emergency use at all public bathing places.

XXI. SUITS, TOWELS, AND CAPS

A. At indoor pools used exclusively by men, nude bathing should be required. At indoor pools used exclusively by women bathing suits should be of the simplest type. Suits when used should be of wool or cotton of simple design and of undyed material or tested for fastness of color. Elaborate suits of varied materials or varied colors should not be permitted.

B. At artificial pools all bathers of both sexes should be required to wear rubber bathing caps.

C. It is desirable at artificial pools that all suits and towels be supplied and cared for by the management. If individually owned suits are permitted, they should be of prescribed style and material and should be laundered and stored at the pool by the management.

D. All suits and towels must be washed with soap and boiling water, rinsed, and thoroughly dried each time they are used.

E. Unless suits and towels are sent to a public laundry, the installation and use of modern laundry equipment at all public bath houses and pools should be required. Cold water washing and air drying should be prohibited. The use of a disinfectant on suits and towels in place of proper laundry methods is a makeshift which should not be permitted.

F. A sufficient number of suits and towels should be provided to take care of the maximum number of bathers. Unless thoroughly dried by artificial heat in a modern laundry drier, suits and towels should not be re-issued on the same day that they have been used.

G. Clean suits and towels must be kept strictly separated from those which have been used and unlaundered. Clean suits and towels must not be stored on shelves, handled in baskets or passed out over counters where dirty suits have been.

XXII. SUPERVISION OF BATHERS

A. A swimming instructor, bathing master or other qualified attendant should be on duty at the pool side at all times when a pool is open to use by bathers. Such attendant should be in full charge of bathing and have authority to enforce all rules of safety and sanitation.

B. An attendant should be on duty at the shower room or entrance to the pool to inspect all bathers for skin diseases, open lesions, etc., and to insure that a proper cleansing bath has been taken.

C. At public bathing beaches one or more life guards should be on duty during all bathing hours.

D. Swimming pool attendants and life guards should be capable swimmers, competent in life saving methods and in methods of artificial resuscitation.

E. No bather should be permitted to enter the pool room or pool enclosure, unless an attendant or other competent person is present. Solo bathing must be absolutely prohibited at all pools.

F. Whenever a pool is empty, entrance of all persons except pool attendants must be effectually prevented.

XXIII. PERSONAL REGULATIONS

A. All persons using a swimming pool must be required to take a cleansing shower bath in the nude, using warm water and soap, and thoroughly rinsing off all soap suds, before entering the pool room or enclosure. A bath after donning a bathing suit should not be permitted.

B. A bather leaving the pool room or enclosure for any reason should take a foot bath before returning. A bather leaving pool to use toilet should be required to take a second cleansing bath before returning.

C. All bathers should be instructed to use the toilet and particularly to empty the bladder before taking cleansing bath and entering the pool.

D. Any person having any skin disease, sore or inflamed eyes, cold, nasal or ear discharges, or any communicable disease must be excluded from a public swimming pool.

E. Persons having any considerable area of exposed sub-epidermal tissue, open blisters, cuts, etc., should be warned that these are likely to become infected and advised not to use the pool.

F. Spitting, spouting of water, blowing the nose, etc., in the pool should be strictly prohibited. Bathers should be instructed that the scum gutter is provided for expectoration.

G. All bathers should be instructed that blowing the nose to remove water is likely to force infectious matter into the sinus and inner ear cavities and possibly cause serious consequences.

H. Divers should be advised to wear rubber caps over the ears or to plug the ears with greased cotton to prevent infection of the ear drum and passages by water forced in by concussion.

I. No boisterous or rough play, except supervised water sports, should be permitted in the pool, on the runways, diving boards, floats, platforms, or in dressing rooms, shower rooms, etc.

J. Suitable placards embodying the above personal regulations and instructions and those relating to suits and towels should be conspicuously posted in the pool room or enclosure and in the dressing rooms and offices at all swimming pools. At a number of boys' club pools the boys are required to memorize the rules for safety and sanitation as a prerequisite to use of the pool.

XXIV. CHEMICAL AND PHYSICAL QUALITY OF SWIMMING POOL WATER

A. *Excess chlorine*.—Whenever chlorine, calcium hypochlorite, or other chlorine compounds, without the use of ammonia, are used for swimming pool disinfection, the amount of available or excess chlorine in the water at all times when the pool is in use shall not be less than 0.4 p.p.m. or more than 0.6 p.p.m. Whenever chlorine or chlorine compounds are used with ammonia, the amount of available or excess chloramine shall not be less than 0.7 p.p.m. or more than 1.0 p.p.m. Attention is directed to the possibility of interference by nitrites with the orthotolidin test, particularly when chlorine-ammonia disinfection is employed. If readings are made on the water to be tested within 5 to 10 minutes after the orthotolidin is added, and samples are kept away from the light during this period, the nitrite interference will be decidedly lessened. Standards for determining chlorine residuals shall be prepared and used according to recommendations in Standard Methods of Water Analysis of the American Public Health Association. Standardized color discs and comparators may be used.

B. *Acidity-alkalinity*.—Whenever alum or sulfate of alumina is used during purification or repurification of swimming pool waters, the water at all times when pool is in use shall show an alkaline reaction. This means that the hydrogen ion content of the pool water shall not fall below 7.0.

C. *Clearness*.—At all times when the pool is in use the water shall be sufficiently clear to permit a black disk 6 inches in diameter on a white field, when placed on the bottom of the pool at the deepest point, to be clearly visible from the side walks of the pool at all distances up to 10 yards measured from a line drawn across the pool through said disk.

D. *Temperatures*.—The water in any swimming pool should not be artificially heated to a temperature above 78° F. The temperature of the air at any artificially heated swimming pool must not be permitted to become more than 8° F. warmer nor more than 2° F. colder than the water in the pool at any time when the pool is in use. For best results it is desirable that air temperatures shall be about 5° F. warmer than the pool temperature.

XXV. BACTERIAL QUALITY OF SWIMMING POOL WATERS

A. *Bacteria count on standard nutrient agar—24 hours—37° C.—and confirmed test*.—Not more than 15 percent of the samples covering any considerable period of time shall contain more than 200 bacteria per ml or shall show positive test (confirmed test) in any of five 10-ml portions of water at times when the pool is in use. All primary fermentation tubes showing gas should be confirmed.

B. All chemical and bacterial analyses should be made in accordance with the procedures recommended in the Standard Methods of Water Analysis of the American Public Health Association in so far as these methods are applicable to swimming pool waters. In order to secure a true picture of the condition of the swimming pool water at the time of sampling, it is recommended that sodium thiosulfate be employed to neutralize the chlorine residual in the water sample bottle during transportation to the laboratory.

C. The part played by the various strains of streptococci in the respiratory diseases and their prevalence in the intestinal, buccal, and nasal discharges make the presence of streptococci in bathing waters very undesirable. Yet to eliminate them from swimming pools would mean decidedly smaller bathing loads and decided increases in chlorine residuals, either or both of which would hamper the usefulness of the pool. The committee calls attention to the fact that streptococci tests are of value in passing on the conditions of swimming pool water but does not recommend any uniform standard limit for their presence.

D. 1. *Preparation of bottle for sampling*.—All bottles of chlorinated swimming pool water shall be collected in bottles treated with sodium thiosulfate. The purpose of using water sample bottles containing sodium thiosulfate is to reduce the chlorine present in a

treated water at the moment the sample is collected to prevent a continuance of the killing action of the chlorine on the bacteria while the sample is being transported to the laboratory. The bacteriological examination then shows the true sanitary quality of the water at the time the sample was collected.

2. Several procedures for preparing the bottles are presented.

FOR MOIST HEAT STERILIZATION

Option 1: The sodium thiosulfate solution is prepared by dissolving 1.5 gm of sodium thiosulfate in 100 ml of distilled water. One-half ml of this solution is placed in each clean bottle. (This amount has been found sufficient to reduce completely residual chlorine in an amount up to 2.0 p. p. m. in a sample of 130 ml of water.) After the introduction of the sodium thiosulfate solution, the bottle is stoppered and capped. The bottles are then placed in an autoclave and sterilized for 15 minutes at a pressure of 20 lb. per sq. in.

Option 2: Into clean wet bottles, add approximately 0.02 to 0.05 gm of powdered sodium thiosulfate. The amount need not be weighed. An estimated amount on the tip of a spatula is sufficiently accurate. The bottles are sterilized as in option 1.

FOR DRY HEAT STERILIZATION

Into clean dry bottles is added from 0.02 to 0.05 gm of powdered sodium thiosulfate as in option 2. The bottles are stoppered, capped, and sterilized at 180° C. for 10 minutes. The temperature of sterilization must not approach 220° C. as sodium thiosulfate decomposes at this temperature.

E. Collection of samples.—The samples should be collected by plunging the open bottle beneath the surface, sweeping the bottle forward until filled. The bottle should not be rinsed in the pool or the sodium thiosulfate will be removed. Samples should be collected only when the pool is in use and preferably during periods of heaviest bathing loads during the day. The hour of the day, the day of the week, frequency of collection, and the location of the point of sampling shall be varied in order to obtain over a period of time a representative cross-section of the sanitary quality of the pool. It is desirable wherever facilities permit, to collect one or more samples weekly from swimming pools.

XXVI. CLEANING POOL

A. Visible dirt on the bottom of a swimming pool shall not be permitted to remain more than 24 hours.

B. Any visible scum or floating matter on the surface of pool shall be removed within 24 hours by flushing or other effective means.

XXVII. BATHING LOAD LIMITS

A. *Frequency of changing water.*—1. The purpose of recirculation is primarily two-fold, first, to remove suspended material and thus produce a clear water, and second, to carry chlorine or chloramine to the water in the pool and thus maintain proper chlorine residuals in the pool water. The clarity of the water is related to the efficiency of the chlorine, in that the presence of suspended material reduces the effectiveness of the residual chlorine. In general, as discussed in Section XVI B, it has been found that the rate of turnover should be three times daily where continuous circulation is used.

2. The total number of bathers using a fill and draw swimming pool shall not exceed one person for each 500 gallons of water in the pool between complete changes of pool water without disinfection. Where intermittent disinfection is employed, the number of bathers using the pool will be governed by the safe limits mentioned under "Proportioning Pool Area to Expected Load," and by bacteriological analyses of the pool water. Chlorine residuals should be maintained within the limits discussed in Section XXIV A. The committee does not recommend the use of fill and draw swimming pools, as stated elsewhere.

3. The total number of bathers using an outdoor pool—partly artificial and partly natural in character, dependent for circulation and replenishment upon an inflow and outflow of water from the supply of a clean stream which is relatively free from bacterial pollution or of a safe well or spring—might be based upon a figure of one person for each 500 gallons of water added to the pool as a maximum limit, although safe bacteriological conditions should be the principal guide. Where pre-cleansing baths are not used at such pools, reductions in bathing loads will undoubtedly be found necessary to maintain safe bacteriological conditions even with high chlorine residuals. Pre-cleansing baths should, of course, be provided at all pools.

B. *Frequency of disinfection.*—The committee has decided to omit a previous recommendation as to bathing load limits between successive disinfections in pools practicing intermittent chlorine disinfection in view of the recommendations as to maintenance of adequate chlorine residual *at all times* the pool is in use. It is pointed out that experience indicates that far better bacteriological conditions can be maintained with continuous chlorine disinfection. Where a pool is operated with wide fluctuation in chlorine residuals, chlorine resistant organisms may develop at times when the chlorine residual content of the water is low, and it may be necessary to use very high chlorine residuals to destroy them.

C. *Area limitation.*—One investigator (Mallmann) has concluded that under normal pool recirculation and design conditions, a maximum bathing load limit of 1 bather per 35 to 45 square feet of pool area will result in safe bacteriological conditions with adequate chlorine residuals. In the light of experience, these figures seem reasonable for swimming pools which are of ordinary dimensions. The area per bather is greater than provided for under the design requirements set under "Proportioning Pool Area to Expected Load," Section VI.

XXVIII. OPERATING CONTROL

A. *Trained operators.*—Each swimming pool should be operated under the close supervision of a well trained operator with common sense and good judgment.

B. *Tests for excess chlorine.*—At any pool where chlorine, hypochlorite of lime or other chlorine compound is used for disinfection, the operator must be supplied with a proper outfit for making the orthotolidin test for excess chlorine and with permanent standards showing maximum and minimum permissible chlorine in the water.

Tests for excess chlorine in the water shall be made as frequently during the day as experience proves to be necessary to maintain adequate residuals.

C. *Tests for acidity.*—At any pool where alum or sulfate of alumina is used or where artificial alkalinity is added to the water, the pool operator must be equipped with a hydrogen ion testing outfit and must take hydrogen ion tests on the water every day the pool is in use, and more often if necessary.

D. *Operating records.*—Every pool operator must be supplied with a proper note book or with blank forms on which shall be recorded every day the number of persons using the pool, peak bathing loads handled, the volume of new water added, the temperature of the water, and the temperature of the air. Whenever a pool is used by both males and females the number of each and whether adults or children should also be recorded. At all pools where artificial circulation, filtration, or any chemical treatment is used, a full daily record must also be kept of the actual time pumps and filters are in operation, of the time each filter is washed or cleaned, of the time and amount of each chemical used or added, of the time the bottom and sides of the pool are cleaned, and the results of all hydrogen ion, excess chlorine, or other tests.

OUTDOOR BATHING PLACES

XXIX. DEFINITION

Under this heading are considered bathing places along small streams, rivers, lakes, and tidal waters. Fill and draw and recircula-

tion bathing pools readily subject to artificial purification or to constant replenishment with uncontaminated water are not included.

XXX. SOURCES OF POLLUTION

In a swimming pool whose water is derived from a public or other supply of unquestioned quality, it may be assumed that the presence of organisms of the coli-aerogenes group indicates pollution by human sewage particles. The presence of such bacteria in outdoor bathing places, however, may be due to the wash from cultivated fields, animals, and generally harmless contamination. Routine bacteriological tests do not differentiate between harmful and harmless contamination in such cases. Harmful contamination may be caused by sewage from boats, individual dwellings, hotels, factories, or other establishments; public sewage systems; refuse dumping; and bathers themselves.

XXXI. FLOWING-THROUGH BATHING POOLS ALONG SMALL STREAMS

The use of small natural or dammed-up pools among small streams by large numbers of bathers is not recommended unless disinfection is provided, as discussed in the following section. Where such pools are proposed to be used, and will be dependent upon the natural stream flow for cleansing and dilution, it should be ascertained that there is a constant and appreciable overflow of water past the dam under all weather conditions when the pool is to be used. Any small pool patronized by a number of bathers is certain to show bacteriological pollution in considerable amounts unless disinfection is provided. While no specific amount of diluting water for such pools can be recommended, it is probably fair to say that less than 500 gallons per bather per day is too small a diluting volume without disinfection.

In New York State, the so-called Becker formula has been used as a practical guide in passing on necessary volumes of diluting water. This formula is $Q=6.25 T^2$ where Q =quantity of water per bather and T =the replacement period in hours. For example, if the flow is such as to replace the pool volume in 8 hours, $Q=400$ and the number of bathers permitted in eight hours would be the capacity of the pool divided by 400. When the replacement period is 12 hours, 900 gallons per bather are required by this formula.

Whether or not disinfection is employed, every effort should be made to eliminate all sources of sewage pollution on small streams or ponds used for bathing and careful sanitary surveys of watersheds are recommended. It is, of course, desirable that bathing be limited to relatively clear bodies of water and that muddy bottoms which will result in turbid water be avoided.

XXXII. DISINFECTION OF SMALL FLOWING-THROUGH BATHING POOLS

Disinfection is desirable to counteract pollution introduced by bathers. Hypochlorite in solution may be added to the pool inlet or at various points over the pool area. Chlorination of the pool inlet may be continuous. Several applications of disinfectant over the pool area during the bathing period are usually preferable to one application. Even with disinfection, the same governing factors should be considered in arriving at maximum bathing loads in small outdoor pools as presented under "Swimming Pools" (Sections VI and XXVII), and also the same limits for chlorine residuals are recommended as for swimming pools. Disinfection of large bodies of water is discussed in the following section.

XXXIII. DISINFECTION OF LARGE BODIES OF WATER

The disinfection of relatively large bodies of water by use of a chloro-boat, so-called, has been used with apparently some success in a few scattered instances. In some locations, bathing areas several acres in area have been disinfected satisfactorily by the use of extensive piping systems along the water bottom either for distribution of chlorine disinfecting solutions or for distribution of large amounts of pumped water drawn from the bathing area and disinfected in the pump suction with chlorine or chlorine and ammonia in what is practically a recirculation system. Where such disinfection is feasible, the same contents of chlorine and chloramine residuals are recommended as have been proposed for swimming pools. Chlorine and ammonia are undoubtedly more practical of application for large outdoor bathing areas than chlorine alone due to the greater persistence of the chloramines in the water. This probably outweighs the disadvantage of the slower disinfecting action of the chloramines as compared with chlorine. While the possibilities of disinfection methods deserve consideration, unless the future brings forth further developments in the way of attempt to establish bacteriological standards for outdoor bathing places, it appears that emphasis will be laid on the reduction of pollution of outdoor bathing areas rather than on attempt to counteract such pollution by disinfection of bathing waters. The use of disinfecting agencies, however, may be developed particularly to guard against dangers from pollution by bathers themselves in those densely populated areas which are not subject to major water changes through the action of tides and currents.

XXXIV. COLLECTION OF SAMPLES FROM OUTDOOR BATHING PLACES

Analyses of samples of bathing waters intelligently interpreted are of great value but full consideration should be given to the conditions

under which samples are collected and the conditions which may exist at other times. The replenishment of bathing water by stream flow, by tidal action, and by wind and temperature currents, the contamination introduced by bathers themselves and the intermittency of various sources of sewage pollution, are all of importance. In considering dangers from sewage pollution of bathing areas, it is well to emphasize that time is a factor of great importance. The hazard from a relatively small amount of sewage pollution in close proximity to a bathing area is far greater than a large amount at a considerable distance.

XXXV. BACTERIOLOGICAL CLASSIFICATION OF BATHING WATERS

In the collection of samples from bathing waters in connection with a scheme of relative classification of bathing waters which is subsequently presented, it is suggested that in arriving at a coli-aerogenes count on samples, a simple procedure is to run 4 or 5 dilutions from 10 ml down on each sample, in accordance with the expected amount of pollution and to assume 1 *B. coli* originally present in the greatest dilution to give a positive test. For example, positive in 10 ml and 1 ml and negative in 0.1 and 0.01 ml would be called 100 *B. coli* per 100 ml. Where so-called anomalous results are occasionally obtained, such as a sample showing positive in 10 ml, negative in 1 ml, and positive in 0.1 ml, it is suggested that the greatest dilution result be recessed to the next, which in the case illustrated would give 100 *B. coli* per 100 ml. This is an arbitrary method of computation, open to some mathematical objections, but it is simple and is satisfactory for all practical purposes. On the basis of experience, where a large number of samples has been handled, presumptive tests on lactose broth may be considered sufficient evidence of the presence of *B. coli*, the resulting error as against complete confirmation according to Standard Methods of Water Analysis being slight.

XXXVI. RELATIVE CLASSIFICATION OF BATHING AREAS RECOMMENDED

In passing on waters of outdoor bathing places, three aids are available: (1) the results of chemical analyses of the water; (2) the results of bacteriological analyses of the water; and (3) information obtained by a sanitary survey of sources of pollution, flow currents, etc. Chemical analyses may in some cases be of value but are not ordinarily delicate enough tests.

It is not considered practicable or desirable to recommend any absolute standard of safety for the waters of outdoor bathing places on any of the three above bases. The arbitrary wholesale condemnation of bathing beaches representing large capital investments is unwarranted without definite epidemiological evidence. A relative

scheme of classification of outdoor bathing places appears to offer the most promising program for public health workers to follow. Due to the difference in local conditions surrounding bathing in tidal waters, large and small lakes, and large and small streams, the degrees of classification of the bathing waters in any particular region may of necessity be varied.

In one State, a classification survey of the shore waters was carried out. The entire shore line was divided into sampling stations about 1,000 feet apart and samples for bacteriological analysis were collected in from 2 to 6 feet of water at high, low, half ebb, and half flood tides at each station. The results were averaged and adjoining stations combined into sections on the basis of the sanitary survey information. The analytical classification for each section was made by averaging the averages for the included stations. The sections were then classified on the basis of the analyses as follows:

	Average <i>B. coli</i> per 100 ml
Class A.....	0- 50
Class B.....	51- 500
Class C.....	501-1,000
Class D.....	over 1,000

These same sections were also classified in Classes A, B, C, and D on the basis of sanitary survey information as to sewer outlets, float studies, etc., and final classifications were based on both the analysis and sanitary survey classifications. In the sanitary survey classifications, Class A was considered good; Class D very poor; and the two intermediate classes ranged from doubtful to poor. Close correlation was obtained between the analysis and sanitary survey classifications.

Proposed bacteriological standards by various agencies have seemed to hit mainly upon two widely divergent limits for standards of acceptability for bathing waters, one of which is 50 *B. coli* per 100 ml and the other of which is 1,000 *B. coli* per 100 ml. It is perhaps reasonable to conclude that, subject to interpretation of analytical studies from proper angles, waters better than the lower limit (1,000 *B. coli* per 100 ml) are fairly acceptable. Both these lines of demarcation are drawn in the classification scheme just presented and the committee recommends the use of this classification scheme unless local conditions make some other classification scheme preferable. If it is desired to set up any intermediate classifications, any classification such as "A" can be broken up into "A+" and "A-." The interpretation of areas falling into Classes B, C, and D as to whether these areas can be considered good, doubtful, poor, or very poor, must for the present be left with the interested State health department or other agency concerned. As further information is gained from the

classification of areas, more definite conclusions may be reached. It is emphasized again that final classifications should not be made upon the basis of bacteriological analyses alone, but should depend largely on correlative sanitary survey information. Allowances should be made and distinctions drawn as to pollution introduced by large bathing loads at outdoor bathing places and pollution derived from sewer discharges or other sources.

The committee feels that the health board or department of each State should be the guiding agency for State-wide studies of outdoor bathing areas, with the assistance of community and district health units where practicable. Information obtained as a result of classification surveys of bathing waters should be in the hands of public health workers to enable them to furnish intelligent answers to inquiries on the part of the public. While data of this type should be released advisedly so as not to cause unwarranted depreciation of property values near bathing areas, it should serve to acquaint the public with danger spots caused by uncontrolled discharge of sewage and to promote the betterment of health conditions by installation of sewage treatment where necessary for the protection of bathing waters. The recent studies and recommendations of the Tri-State Pollution Commission (New York, New Jersey, and Connecticut) point out what may be done in the way of specifying degrees of treatment for discharge of sewage into waters allocated for recreational purposes.

XXXVII. SANITARY APPURTENANCES AT OUTDOOR BATHING PLACES

Attention is directed to the need for proper sanitary appurtenances at outdoor bathing places. The remarks in sections XII and XIII under "Swimming Pools" with regard to dressing rooms, showers, toilets, and lavatory accommodations, are also pertinent as to outdoor bathing places.

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